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**UNITED STATES PATENT APPLICATION**

**OF**

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**FOR**

**LIQUID CRYSTAL DISPLAY DEVICE HAVING REMOVABLE PRINTED  
CIRCUIT BOARD**

[illegible]

is disposed over the liquid crystal panel 110 to press the liquid crystal panel 110, thereby fixing the liquid crystal panel 110 between the lower and upper frames 120, 130. The back light unit 140 serves as a light source to provide light rays for the liquid crystal panel 110. The lower frame 120 is usually a plastic and supports the back light unit 140 as well as the liquid crystal panel 110.

[0005] The upper substrate (not shown) of the liquid crystal panel 110 has a color filter, a black matrix, and a common electrode. The color filter colors the light rays that radiate from the back light unit 140 as the light rays pass through the liquid crystal layer of the liquid crystal panel 110. The black matrix blocks needless portions of the rays. The lower substrate (not shown) of the liquid crystal panel 110 has a switching element and a pixel electrode. A thin film transistor (TFT) is generally used as the switching electrode. Together with the common electrode of the upper substrate, the pixel electrode applies an electric field to the liquid crystal layer. The liquid crystal panel 110 further has an upper polarizer (not shown) and a lower polarizer (not shown), that are respectively formed on the upper substrate and the lower substrate.

[0006] As shown in FIG. 2, the lower frame 120 has a base plate 122 and four side walls 124 that are respectively connected with the four side edges of the base plate 122. A front side wall 124a specifically serves to support the back light unit 140 shown in FIG. 1.

[0007] FIG. 3 shows the upper frame 130 which is generally made of metal. The upper frame 130 has the shape of a rectangular doughnut, and each side edge thereof has an

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[0009] The liquid crystal display module 100 of FIG. 1 further includes a printed circuit board (PCB, reference 150 of FIG. 4) where driving circuits are installed to drive the liquid crystal display module 100. As shown in FIG. 4, the PCB 150 is electrically connected with the liquid crystal panel 110 via a tape carrier package (TCP) 152 (usually a flexible film). A drive IC (integrated circuit) 154 is installed in the TCP 152.

**[0011]** At first, all the elements of the back light unit 140 are sequentially mounted on the lower frame, and the liquid crystal panel 110 is mounted on the back light unit 140. After the liquid crystal panel 110 is properly adjusted such that the lower frame 120 can support it, the upper frame 130 is aligned over the lower frame 120 and pressed on such that the liquid crystal panel 110 is fixed therebetween. At this point, the PCB 150 is bent along a rear side edge 124b (of FIG. 2) of the lower frame 120 such that it is fixed on the lower surface of the back light unit 140. Screws or double-coated tapes are

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## SUMMARY OF THE INVENTION

**[0014]** An object of the present invention is to provide a liquid crystal display device that is easy and safe to repair without deteriorating display quality.

[0016] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the

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[0018] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

[0019] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description

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[0034] FIGs. 15A and 15B are respectively a side view and a partially expanded view illustrating a coupling configuration for the second printed circuit board of FIG. 14.

[0036] As shown in FIG. 5, an exemplary liquid crystal display module 200 according to the present invention includes a liquid crystal panel 210, a lower frame 220, an upper frame 230, and a back light unit 240. The liquid crystal panel 210 has an upper substrate, a lower substrate, and a liquid crystal layer interposed therebetween. The lower frame 220 is disposed under the liquid crystal panel 210 to support the liquid crystal panel 210. The upper frame 230 is disposed over the liquid crystal panel 210 to press on the liquid crystal panel 210, thereby fixing the liquid crystal panel 210

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between the lower and upper frames 220 and 230. The lower frame <sup>2</sup>220 is usually a plastic, and serves to support the back light unit <sup>2</sup>240 as well as the liquid crystal panel <sup>2</sup>210. The back light unit 240 serves as a light source for the liquid crystal panel 210.

The lower frame 220 may be made of plastic and supports the back light unit 240 as well as the liquid crystal panel 210.

10/13/02 [0037] The upper substrate (not shown) of the liquid crystal panel 210 has a color filter, a black matrix, and a common electrode. The color filter colors light radiating from the back light unit 240 into the liquid crystal layer of the liquid crystal panel 210. The black matrix blocks needless portions of the light. The lower substrate (not shown) of the liquid crystal panel 210 has a switching element and a pixel electrode. A thin film transistor (TFT) is preferably used as the switching electrode. Together with the common electrode of the upper substrate, the pixel electrode applies an electric field to the liquid crystal layer. The liquid crystal panel 210 further has an upper polarizer (not shown) and a lower polarizer (not shown) respectively formed on the upper substrate and the lower substrate.

[0038] As shown in FIG. 6, the lower frame 220 has a base plate 222 and four side walls 224, which are respectively connected with the four side edges of the base plate 222. A front side wall 224a supports the back light unit 240 shown in FIG. 5. Opposite to the front side wall 224a, a rear side wall 224b is formed.

[0039] The base plate 222 has protrusions 226 to fix a control printed circuit board (PCB) 260 (of FIG. 10). Preferably, four protrusions 226 are formed surrounding a

region where the control PCB 260 will be disposed. Each protrusion 226 may be bent to have the shape of a capsized letter "L" or the shape of a hook. That is, as shown in FIG. 15B, the protrusion 226 may have a perpendicular portion 226a and a parallel portion 226b defining an angle of about 90 degrees therebetween. The perpendicular portion 226a protrudes perpendicular to a bottom surface 222a of the base plate 222, and the parallel portion 226b extends parallel with the bottom surface 222a such that the protrusion 226 has the shape of the hook. An exemplary perpendicular portion 226a may have the same height as the thickness of the control PCB 260 such that the control PCB 260 cannot move after fixed by the protrusion 226. The protrusion 226 may have various shapes only to fix the control PCB 260 properly.

[0040] FIG. 7 shows the upper frame 230 made of metal, for example. The upper frame 230 has the shape of a rectangular doughnut, and each side edge thereof includes a side wall 234 so as to have an L-shaped section. The side edges of the upper frame 230 surround the liquid crystal panel 210, and are coupled with the lower frame 220. A plurality of flexible concavities 232 are formed on each side wall 234 to couple with the lower frame 220.

[0041] Returning to FIG. 5, the back light unit 240 has a reflector 240a, a light guide 240b, a first diffusing or protecting film 240c, a first prism sheet 240d, a second prism sheet 240e, a second diffusing or protecting film 240f, and a lamp 242. The lamp 242 produces light to the liquid crystal panel 210.

[0042] The liquid crystal display module 200 of the present invention further includes a

lower cover 300 shown in FIG. 8. The lower cover 300 has a main portion 302 and auxiliary portions 304 that are bent perpendicular to the main portion 302. A first screw hole 306 is formed passing through the main portion 302, and a second screw hole 308 is formed passing through the bent portion 304. The first screw hole 306 couples the lower cover 300 with the lower frame 220, and the second screw hole 308 couples the lower cover 300 with the upper frame 230.

[0043] In addition, a side wall 309 is formed along a side edge of the lower cover 300. The side wall 309 is also bent perpendicular to the main portion 302 protects the lamp 242 (of FIG. 5) of the back light unit 240 (of FIG. 5) or protects the bent portion of a TCP 252 (of FIG. 9). A coupling segment 309a is formed on the side wall 309 to couple the lower cover 302 with the upper cover 230.

[0044] Lower cover 300 supports the lower frame 220 along a long direction of the lamp 242 (of FIG. 5) of the back light unit 240 to prevent bending or wrinkling the lower frame 220. Therefore, stainless steel, such as SUS, is used as the material of the lower cover 300. The lower cover 300 may be disposed opposite to the lamp 242 (of FIG. 5) so as to correspond to the position of a PCB (reference 270 of FIG. 9).

Alternatively, two lower covers 300 may be used to support the lower frame 220 along both directions of the lamp 242 and the PCB 270.

[0045] The liquid crystal display module 200 of FIG. 5 further includes the printed circuit board (PCB) 270 (of FIG. 9) having driving circuits to drive the liquid crystal display module 200. As shown in FIG. 9, the PCB 270 may be divided into a source

PCB 250 and the control PCB 260. The control PCB 260 is electrically connected with source PCB 250 via a flexible printed circuit (FPC) 280 (of FIG. 10) and a connector 330 (of FIG. 12A). The source PCB 250 is electrically connected with the liquid crystal panel 210 via the tape carrier package (TCP) 252, which may include a flexible film. A drive IC (integrated circuit) 254 is installed in the TCP 252. In addition, main drive circuit elements to drive the liquid crystal panel 210 are installed on the control PCB 260.

[0046] Regardless of the electrical connection via the FPC and the connector, the control PCB 260 and the source PCB 250 are preferably independent of each other. Therefore, the control PCB 260 can be electrically separated from the source PCB 250 by removing the FPC 280 (of FIG. 10) from the connector 330 (of FIG. 12A) of the control PCB 260. Accordingly, the FPC 280 (of FIG. 10) is just pulled out from the connector 330 (of FIG. 12A) of the control PCB 260 for the separation between the control PCB 260 and the source PCB 250. Therefore, when a defect occurs in the main drive circuit elements of the control PCB 260, the control PCB 260 is easily removed from the source PCB 250 to repair the defects.

[0047] With reference to FIG. 11, the structure of the control PCB 260 will now be explained in detail.

[0048] As shown in FIG. 11, notches 290 are formed at right and left side edges of the control PCB 260. The positions of the notches 290 correspond to those of the protrusions 226 of the lower frame 220. An interval defined between a first notch and a

second notch formed at the same side which is preferably smaller than the corresponding side length of the control PCB 260 (of FIG. 10).

[0049] The number of notches 290 and protrusions 226 are not required to be the same, and the number of notches 290 and protrusions 226 are not fixed. That is, if only the control PCB 260 is firmly coupled with the lower frame 220 via the notches 290 and the protrusions 226, the number of the notches 290 or the protrusions 226 may be varied.

[0050] Returning now to FIG. 5, a process for assembling the above-described liquid crystal display module 200 will now be explained.

[0051] At first, all the elements of the back light unit 240 are sequentially mounted on the lower frame 220. Then, the liquid crystal panel 210 is mounted on the back light unit 240 and is adjusted such that the lower frame 220 supports the liquid crystal panel 210. At this point, the source PCB 250 connected with the liquid crystal panel 210 is bent along a rear side wall 224b (of FIG. 6) of the lower frame 220 to fix the source PCB 250 on the lower surface of the back light unit 240. Thereafter, the control PCB 260 connected with the source PCB 250 via the FPC 280 (of FIG. 10) is coupled to the lower frame 220. The coupling method for coupling the control PCB 260 with the lower frame 220 will be explained later.

[0052] Thereafter, the two lower covers 300 are fixed to the lower frame 220 via a screw coupling, for example. Specifically, the two lower covers 300 are arranged to support, respectively, the front side wall 224a supporting the lamp 242 of the back light

unit 240 and the rear side wall 224b opposing the front side wall 224a. Then, screws (not shown) are tightened through the first and second screw holes 306 and 308 of the lower cover 300 to fix the lower cover 300 to the lower frame 220.

[0053] Thereafter, the upper frame 230 is aligned over the lower frame 220 and pressed onto the liquid crystal panel 210 to fix between the upper and lower frames 220 and 230. At this point, the coupling segments 309a of the lower cover 300 are latched into the flexible concavities 232 of the upper frame 230. Though after the upper frame 230 and the lower frame 220 are coupled with each other, the control PCB 260 (of FIG. 9) can be easily removed from the lower frame 220 without disassembling the upper and lower frames 230 and 220. Before the control PCB is removed from the lower frame 220, the FPC (reference 280 of FIG. 10) is unlatched from the connector 330 (of FIG. 12A) of the control PCB 260 such that the control PCB 260 and the source PCB 250 (of FIG. 9) are separated. Alternatively, the FPC may be unlatched from the connector after the PCB is removed from the lower frame 220.

[0054] FIG. 10 is a bottom plan view illustrating the liquid crystal display module 200 assembled via the above-explained process. As shown, the control PCB 260 is mounted on the base plate 222 of the lower frame 220 and is electrically connected with the source PCB 250 via the FPC 280. The source PCB 250 is bent on the lower surface of the back light unit (reference 240 of FIG. 5).

[0055] With reference to FIGs. 12A, 12B, 13A, and 13B, a method for mounting the control PCB 260 will be explained in detail. FIGs. 12A and 13A are expanded plan

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views of a portion "A" of FIG. 10, and FIGs. 12B and 13B are partial expanded view<sup>5</sup> of FIGS. 12A and 13A, respectively.

[0056] In FIGs. 12A and 12B, the notches 226 of the control PCB 260 are respectively aligned to the coupling segments 290 formed on the base plate 222 of the lower frame (reference 220 of FIG. 6). Then, the control PCB 260 is slid in the direction of the arrow such that the notches 290 are away from the coupling segments 226. Thus, the coupling segments 226 squeeze the side edges of the control PCB 260 such that the control PCB 260 is coupled to the bottom plate 222 of the lower frame 220 (of FIG. 6).

[0057] After the control PCB 260 is coupled to the bottom plate 222, the FPC 280 connected with the source PCB 250 (of FIG. 10) is connected to the connector 330 of the control PCB 260 such that they are electrically connected. Alternatively, the FPC 280 may be connected to the connector 330 before the coupling of the control PCB 260 and the bottom plate 222.

[0058] FIGs. 14, 15A, and 15B illustrate another configuration of the second printed circuit board. As shown in FIG. 14, the control PCB 260 has just one notch 292 at a first side edge 294, and there is no notch at a second side edge 296 opposite the first side edge 294. The notch 292 is preferably formed near a lower side edge 298 of the control PCB 260. In that case, as shown in FIGs. 15A and 15B, the second side edge 296 of the control PCB 260 is inserted into a gap under the coupling segment 226 formed at a first inner side of the basic plate 222 of the lower frame 220 (of FIG. 6). Then, the notch 292 is aligned to the coupling segment 226 formed at a second inner

side opposing ~~to~~ the first inner side of the basic plate 222. Thereafter, the control PCB 260 is slid in a direction of the arrow of FIG. 15A such that the coupling segments 226 squeeze the control PCB 260.

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[0059] In an exemplary configuration, the coupling segments and notches couple the control PCB with the lower frame. The coupling segments and notches may alternatively be substituted with screws and screw holes or the like. In addition, though the coupling segment of the illurstrated configuration is integrally formed with the lower frame, the coupling segment may be formed independently of the lower frame such to be removable from the lower frame.

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[0060] As explained above, the present invention may provide a removable control PCB that can be separated from the lower frame and the source PCB without disassembling and reassembling of the upper and lower frames. Therefore, the driving circuits formed on the control PCB can be repaired or exchanged without additional complication, and contamination due to the dissembling or reassembling can be excluded. Further, because there is no screw or double-coated-tape used for fixing the PCB, the fabrication cost and yield are improved.

[0061] It will be apparent to those skilled in the art that various modifications and variation can be made in the liquid crystal display module of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.